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Virtual Learning Environment for Next Generation in Electronics & Telecommunications Courses

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***Abstract*— The learners' perspective on virtual laboratory of electronic and telecommunications courses in ODL mode of teaching, such as expectations, 'learning outcomes' and 'satisfaction', are reported. Few middle level courses offered in B.Tech Electronics & Telecommunication Engineering were selected for the study. A comparison with conventional university lab-work was carried out with all participants of virtual laboratory in order to validate the objective. The perception of difficulty in learning electronic and telecommunications course via distance is in general. However, the basic familiarity with the course subject, the less difficulty they anticipate in learning electronic and telecommunications courses via distance education.**

Keywords- Learner perspective of virtual lab work, LO (learning outcome), ODL (open distance learning) Learner expectation, Learner Satisfactio.

I. INTRODUCTION

Virtual access to experiments offers distance educators another tool to integrate a strong laboratory component within science and technology courses. Since virtually all modern electronics instrumental analysis in industry now use devices operated by a computer interface, remote control of instrumentation is not only relatively facile, it enhances participants' opportunity to learn the subject matter and be exposed to "real world" contents. Most of the universities are now developing teaching laboratories based on the control of analytical instruments in real-time via an Internet connection. Participants perform real-time analysis using equipment, methods, and skills that are common to modern analytical laboratories (or sophisticated teaching laboratories). Participants obtain real results using real substances to arrive at real conclusions, just as they would if they were in a physical laboratory with the equipment; this approach allows participants to access to conduct instrumental science experiments, thus providing them with an advantageous route to upgrade their laboratory skills while learning at a distance [1-5].

A strong laboratory component is at the heart of many science courses. It is also one of the more challenging components to deliver effectively at a distance [2-4]. There is no one correct solution or technology and often an assortment of methods are used in concert to overcome these challenges. The methodology and success of varying approaches to delivering science laboratories in the area of electronics and telecommunications hasn't been discussed elsewhere. In each instance, however, the intent is to offer students a laboratory experience equivalent to, but not necessarily identical to, that they would encounter in a more traditional face-to-face setting.

With the availability of the World Wide Web, both campus and distance-based educators in disciplines like electronics and information communication technology, which traditionally have a strong laboratory component, have been exploring the integration of experiments into their face-to-face and online courses. In many instances, the online laboratory components are simulated and offer the "so-called" virtual laboratory experience [4]. A few groups, however, have directed their efforts towards allowing students remote access to real experiments. For example, an optical experiment at Stanford University in the United States is described under the Cyberlab project (Hesselink, Rizal, and Bjornson, 2000) [11]. There is also the PEARL project (Practical Experimentation by Accessible Remote Learning) which is a consortium of European Union (EU) institutions developing remote experiments in spectrometry, manufacturing engineering, and electronic engineering [6]. Our own research has primarily focused on controlling sophisticated analytical instruments in electronics & information communication technology. Most modern analytical instruments are intimately controlled by computer, thus making access by remote control possible. Several others have already reported using the commercially available LabVIEW software system for controlling instrumentation and acquiring data in an in-class teaching environment [7-11]. In present study, which allowed B.Tech of Electronics & Communication students to control analytical instruments in real-time, we demonstrated that open source software like ORCAD based PSPICE and commercially available software like MULTISIM 10, which works as a client-server application can be achieved from a remote location over the Internet. Although the initial study has shown the viability of this concept, the present work describes adapting this technology to a teaching environment that allows students both facile access to instrumental electronics experiments and an advantageous route to upgrade their laboratory skills at a distance. Bernard and coworkers recently presented evidence through a comprehensive meta-analysis of empirical literature that distance education was generally comparable with classroom instruction on a number of variables including retention and learning outcomes [5].

Building on the contention that classroom and distance delivery could be equivalent, we were interested in a comparison of a virtual teaching laboratory environment with the face-to-face environment. Our intent was to create a virtual laboratory experience that is comparable with traditional laboratories. We wanted to determine whether facilitating real laboratories at a distance through remote technologies could be achieved and demonstrated within the context of specific experiments. In addition to our main consideration of virtual laboratory we determined various aspects of learning electronic and telecommunications courses at a distance, such as expectations, 'learning outcomes' and 'satisfaction', we also briefly describe the virtual lab of analog and digital electronics courses.

II. SAMPLE & METHOD

PSPICE software as shown in Fig.1 is used in the virtual lab work of analog and digital electronics courses of electronics and telecommunication programme. The Simulation Program with Integrated Circuit Emphasis (SPICE) circuit simulation tool was first developed in the early 1970s. It was written in the FORTRAN programming language and was intended to support the early data entry methods of this period. SPICE was immediately valuable to allow circuit designers to analyze circuit systems, in particular as the complexity of circuits began to expand with the arrival of the first integrated circuits. It is certainly one of the most important tools for all the electronics courses.

SPICE has evolved with many advances in numerical analysis methods for accurate and fast computation and has appeared in many commercial forms. SPICE has been ported to many platforms and the version that operates over the Windows operating system is PSpice.

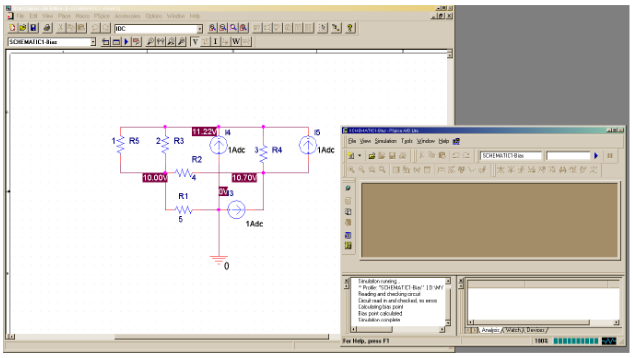

Figure 1. pSpice platform

The first SPICE users designed circuits with manual circuit drawing tools. Then, inspection of the circuit design was used to generate a text-based description of the circuit design. Even today this still occurs in certain special instances. However, the arrival of graphical drawing tools allows a circuit designer to directly draw circuit schematics using circuit design tools and then special "capture" tools operate to "capture" the schematic and generate the text-based description of the circuit design, automatically. The versions of PSpice available to us operate in this way.

This is a great advantage for the engineering design process – this provides the designer with the ability to focus directly on a visual description of their system and obtain circuit operation numerical and graphical results in an automatic, convenient process.

The NI Electronics Education Platform is used in the virtual lab work of Logic Circuits & Digital Design course of School of Science and Technology. The NI ELVIS is an end-to-end tool chain designed to meet the needs of students and educators. It is an ideal mix of integrated hardware and software that guides students through the engineering and design process from understanding circuit theory to developing and simulating designs, and then on to prototyping and validation.

Figure 2. NI Elvis Setup

The platform of NI ELVIS as shown in Fig.2, 3 & 4 consists of NI Multisim, the NI ELVIS prototyping workstation, and NI LabVIEW and Signal Express. NI Multisim provides intuitive schematic capture and SPICE simulation to help students explore circuit theory and investigate behavior.

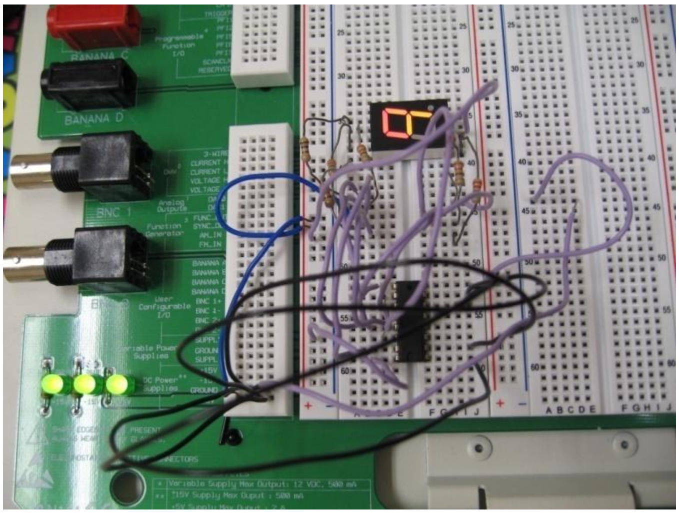

Figure 2 NI Elvis Platform

Multisim also includes a 3D prototyping environment which can help students to bridge from a software environment to real-world designs. The NI ELVIS is a prototyping platform that allows students to quickly and easily develop their circuits and take measurements interactively using 12 built-in virtual instruments such as an oscilloscope, multimeter, variable power supply, and function generator. NI LabVIEW and SignalExpress are ideal environments which offer intuitive interfaces to measurements, and allow students to compare their measurements and simulations on the same display.

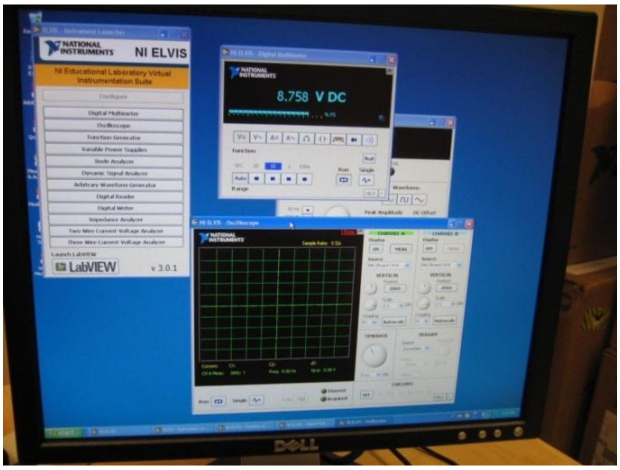

Figure 3 NI Elvis window

A survey between all the participants of NI ELVIS & PSPICE virtual laboratory was conducted for this study using the following questionnaire:

III. SURVEY & FEEDBACK

A. Questionnaire for use of virtual laboratory:

1. "I think it is more difficult to learn electronics & telecommunications courses via distance education than the case of face-to-face"

   A. YES
   B. NO
   C. Can't Say

2. "I think it is more challenging to learn electronics & telecommunications courses via distance education than the case of other subjects related to Social Sciences or Humanities (e.g., Economics, Language, Law, Management, etc).

   A. YES
   B. NO
   C. Can't Say

3. "I think it is essential for electronics & telecommunications courses to include practical work even though the course materials are delivered in a distance mode of education"

   A. YES
   B. NO
   C. Can't Say

4. "I think that lab work can be replaced by virtual components that do not require a face-to-face class"

   A. YES
   B. NO
   C. Can't Say

5. Learning Outcomes
   A. The virtual lab brought me a new perspective of learning science.
   B. The virtual lab helped me prepare for examinations.
   C. The virtual lab helped me complete an assignment.
   D. The virtual lab helped me learn how to use experiment tools.
   E. The virtual lab helped me understand the course material better.
   F. The virtual lab helped me sustain my interest in the course subject.
   G. The virtual lab made the whole course more interesting.
   H. The virtual lab was a special experience itself.

6. Overall Perceptions of the virtual lab
   A. Virtual Lab to conduct science experiments is equivalent to face to face lab
   B. Virtual Lab to conduct science experiments is not equivalent to face to face lab
   C. Virtual Lab to conduct science experiments gives more analytical tools
   D. Face to Face lab provides more hands-on knowledge than virtual lab
   E. Can't say

All participants were asked to answer the above questions and solicit their opinions of the virtual lab method used for teaching electronics and telecommunications courses. The data obtained then underwent content analysis using contextual analysis on pre-determined topics. To ensure the participants would be representatives of entire school of engineering and technology, participants from electronics and telecommunication streams were surveyed. Respondents' ages ranged from 21 to 70 years and faculty's teaching experience ranged from five years to 35 years. Few faculty members had ODL experience and some indicated that they had traditional teaching experience. Two were wholly new to teaching, having neither taught industrial or academic courses. Although all reported that they lacked experience teaching at a distance, all students & faculties participated held the opinion that technical courses could be taught at a distance using virtual lab, but only if proper arrangements were made to ensure course components.

IV. CONCLUSION & RECOMMENDATIONS

This study finds that all participants of virtual laboratory are agreed with the equivalence of virtual laboratory and face-to-face experiments. However, these scenarios should be further explored in more detail for higher level capstone courses of any programme and for project courses. With the virtual laboratory work, both the learning and the cost effectiveness will be easier to measure.

Our intent was to explore the possibilities of virtual lab in all the technical courses, which we find acceptable because we found that face-to-face mode of teaching also use the virtual laboratory work in higher level courses of electronics & telecommunications programme. Any education systems want participants to think about what they are doing, rather than being spoon fed instant answers so it was a good and exciting text of participants. We also feel that it would be informative to pilot some of these experiments with groups of students. This would effectively require students to communicate and learn on

their own at a distance, rather than dropping email to faculty for the help. Another feature we would like to incorporate is a trouble-shooting flowchart, or frequently asked questions, or autonomous agent, to assist student learning through ODL. With the feedback received we suggest that distance education implementation of virtual laboratories techniques can gain in importance and contribute in a significant way to science teaching through ODL.

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